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OCR
Oxford Cambridge and RSA

A LEVEL

Examiners' report

GEOLOGY

H414

For first teaching in 2017

H414/02 Summer 2024 series

Version 1

Contents

Introduction

Our examiners’ reports are produced to offer constructive feedback on candidates’ performance in the examinations. They provide useful guidance for future candidates.

The reports will include a general commentary on candidates’ performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. A selection of candidate answers is also provided. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.

A full copy of the question paper and the mark scheme can be downloaded from OCR.

Paper 2 series overview

The OCR H414/02 GCE Geology A Level paper is synoptic in nature and assesses content from all the 1 to 7 geology teaching modules. There is an emphasis on scientific literacy – the ability to comprehend a passage of text of A Level standard, to extract information from it and to use the information to answer the questions posed.

Most candidates were well prepared and were able to plan their time to answer all the questions in the allotted time with no evidence that any ran out of time. In the main, candidates confined their answers to the answer lines given in the examination booklet, which should be more than enough space to attain the maximum marks available for each question.

The standard of answers to the two 6 mark Level of Response questions (LoR) continue to show improvement. The questions were answered with more assurance and there were few 'no responses'. Candidates coped well with Question 5 which assessed practical skills and laboratory experiments to investigate sediment deposition which may have been unfamiliar to many. The list of indicative points given in the guidance column of the mark scheme for these questions are not exhaustive and candidates do not have to include all the points in order to attain the highest level. What candidates do have to do to attain Level 3 is ensure they fulfil all the requirements of the question.

Most candidates dealt with the mathematical requirements of the paper better than in previous years. Those candidates who had been given opportunities to practise the required mathematical skills (Appendix 5e of the specification) were able to demonstrate their proficiency and performed well on the mathematical skills questions.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• read the questions carefully, taking note of all the information supplied and the command words used • used their knowledge and understanding from different areas of the specification when answering individual questions • had good command of correct geological terminology and knowledge and were able to apply what they had learnt to unfamiliar contexts • produced clear and concise answers to the level of response questions which included sufficient detail and addressed all the requirements of the questions • performed mathematical calculations with confidence, following the required rubric, e.g., clearly laid out working, use of correct units and significant figures • drew, labelled and plotted graphs and diagrams carefully and accurately using a sharp HB pencil.	• wrote under-developed answers which either repeated the questions or did not clearly address what the questions asked • did not have the depth and breadth of geological understanding required to answer the mainly synoptic questions on this paper • did not have good command of correct geological terminology and knowledge and found it difficult to apply what they had learnt to unfamiliar contexts • produced unstructured responses to the Level of Response questions which were lacking in depth and explanation or contained incorrect and contradictory information • were unable to tackle the mathematical skills questions with any confidence and made frequent errors • were careless and inaccurate when plotting graphs, drawing and labelling diagrams, which gained little or no credit.

OCR support

All key documents, supporting guides and resources to support teaching of the OCR A Level Geology course can now be found in one place on the Teach Cambridge website.

Question 1 (a) (i)

1
(a)
(i) Draw a fully labelled diagram to show the processes of saltation and traction along a river bed.

[2]

The processes of saltation and traction were well-known, and most candidates were able to draw a suitable labelled diagram(s) to show these processes of transport along a riverbed. Some candidates forgot to draw in the riverbed, while others did not label which diagram was which. This limited their mark to a maximum of one. Candidates were not penalised for using incorrect terminology such as rocks and stones but should be encouraged to use correct terms such as grains or particles when referring to sediment.

Question 1 (a) (ii)

(ii) Given a constant flow velocity, explain how particles of the same grain size can be transported by saltation or suspension.

....

.... **[1]**

Candidates found this question more challenging. Less successful responses ignored the information given in the question of 'a constant flow velocity' and 'particles of the same grain size' and suggested the reason was either due to different flow velocities or different grain sizes. Some gave descriptions of the two processes which did not attain credit.

Question 1 (b)

(b) Describe the differences between sediments which are texturally mature and texturally immature. Explain how sediments become texturally mature.

[3]

This question was done well. It was well-known that texturally mature sediments tend to be well sorted, have well rounded grains, with a finer average grain size. Compared to immature sediments which would be poorly sorted, have angular grains, with a coarser average grain size. However, not all candidates used correct descriptive terminology, while others described differences in mineralogy or composition which do not constitute a sediment's texture.

Most candidates recognised that sediments become mature as a result of the erosional processes that occur during transport. A small minority were confused with weathering, the in-situ breakdown of rocks, which has no influence on the maturity of any sediment produced.

Assessment for learning

From the outset candidates should be encouraged to use correct technical terminology to describe the texture of sediments. The '3 s's' that make up sediment texture are size, shape and sorting.

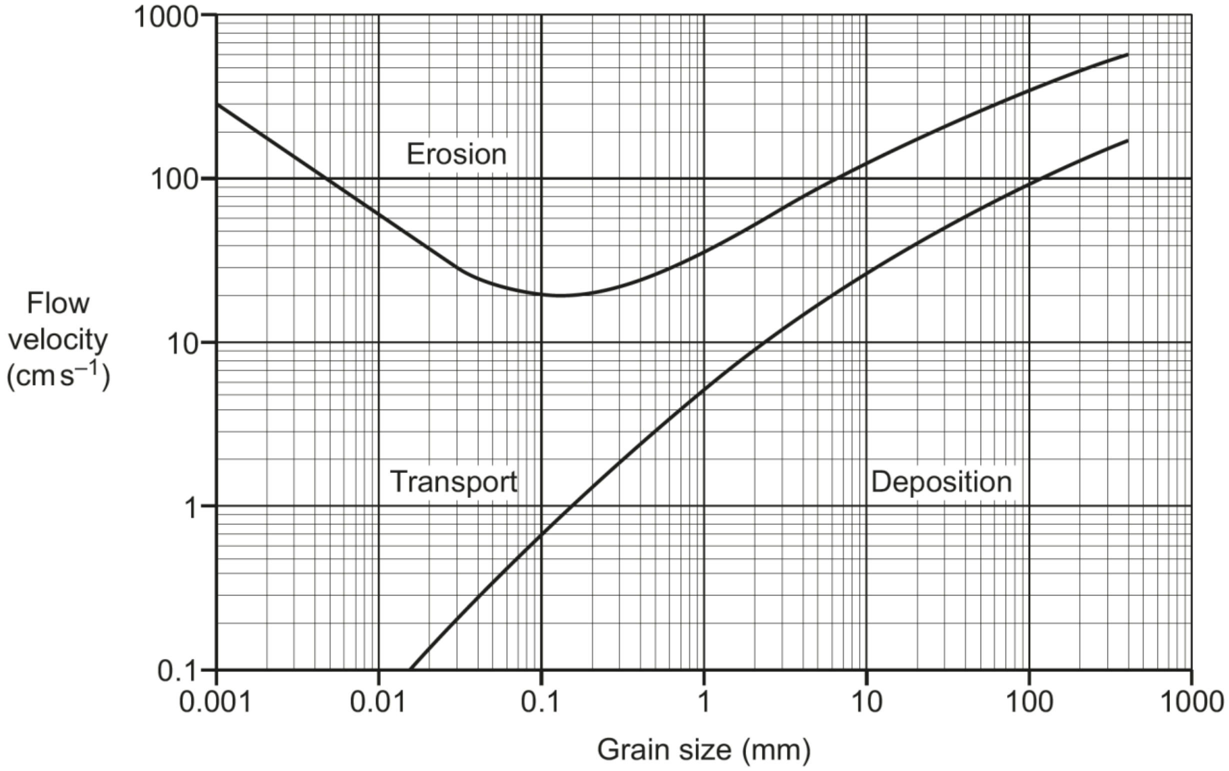
Grain size should be referred to as fine, medium or coarse.

Grain shape includes roundness and sphericity. The six correct descriptors for roundness are very angular, angular, subangular, subrounded, rounded and well rounded and only these precise terms should be used.

Sorting, the degree to which the grains are the same size, is correctly described as poor, moderate or well.

Question 1 (c) (i)

(c) The Hjulström curve graph shows the relationship between the grain size of a sediment and the flow velocity required for erosion, transportation and deposition.



(i) State the minimum flow velocity required to erode a grain size of 1 mm.

Minimum flow velocity = ... Unit = ... **[1]**

Just over half the candidates understood how to read a logarithmic scale. A common mistake was forgetting that the labelled line being read up from was 10. Reading up two more lines from this gets to 30, not 20. Some were not precise enough, perhaps not ruling across the graph horizontally, and gave a value of 40. The correct value was clearly below the 40 line. Given the prompt for units, very few candidates forgot to include them, but not all were correct. A common error was giving a combination of the cm s^{-1} and cm/s notations.

Question 1 (c) (ii)

(ii) State the maximum grain size that would be deposited if the flow velocity slowed to 2 $cm\,s^{-1}$.

Maximum grain size = ... Unit = ... **[1]**

More candidates answered this question correctly but there was the same issue as for the previous question. Candidates overlooked that they were reading 2 along from the 0.1 mm line, so the most common incorrect answer provided was 0.2 mm. Most gave correct units.

Question 1 (c) (iii)

(iii) Explain why both axes of the Hjulström curve graph use logarithmic scales.

....

.... **[1]**

About half of the candidates correctly suggested that logarithmic scales are used on the Hjulström graph to allow for the large range of grain sizes and flow velocities seen in nature. However, some struggled to articulate this into a creditworthy answer.

Question 1 (d) (i)

(d) Diagenesis refers to the physical and chemical processes that change unconsolidated sediments into sedimentary rock.

(i) Name and explain the physical processes that occur during diagenesis.

....

....

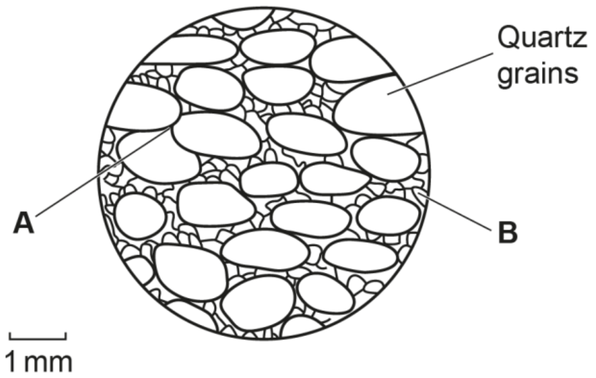
....

.... **[2]**

Most candidates accessed some credit for their answers to this question. Some seemed unclear of what the term physical processes meant and wrote about both compaction (physical process) and cementation (chemical process). Candidates who wrote about compaction first were fortunate as the list rule was invoked and only the first process and explanation were marked. In general, candidates who correctly named compaction or burial were able to provide sound explanations of these diagenetic processes.

Question 1 (d) (ii)

The thin section diagram shows a sandstone.



(ii) During diagenesis, cement can form in a sedimentary rock by two separate chemical processes.

Name and explain the most likely diagenetic process that will occur at point **A** shown on the diagram.

....

....

....

.... **[2]**

Candidates who named pressure dissolution as the diagenetic process most likely to occur at point **A** were in the minority. Credit was also given for the term stylolitisation or stylolite formation. Of those who knew the correct answer, some did not attain the second mark as they did not explain that pressure dissolution occurs at the point of contact between grains. A few gave incorrect answers suggesting metamorphism or melting would occur.

Question 1 (d) (iii)

(iii) Name and explain the most likely process by which cement will form at point **B** shown on the diagram.

....

....

....

.... **[2]**

The processes of precipitation or cementation were better known, but candidates did not always attain the explanation mark. Although candidates may have described the movement of groundwater through sediments, many did not convey the idea that the minerals that form cement are dissolved or in solution. Common errors included referring to sediment, fine grains, clay and matrix infilling between the grains. In addition, some candidates suggested that evaporation resulted in the precipitation of the mineral cement which is not the case.

Assessment for learning

The distinction between cement and matrix should be made clear to candidates.

Cement is crystalline and forms when minerals in solution are precipitated between grains in sedimentary rocks during diagenesis. It is secondary in origin.

Matrix is fine-grained sediment deposited between coarser grains in a sedimentary rock. It is primary in origin.

Question 1 (d) (iv)

(iv) Diagenesis may continue after the sediment has been converted into a rock, causing textural changes.

Describe and explain how continued diagenesis of a sandstone may affect its ability to act as an aquifer rock.

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....

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....

.... **[3]**

This question was well understood, and most candidates accessed some credit for their knowledge of how diagenesis of a sandstone may affect its ability to act as an aquifer rock. A reduction in porosity which would decrease the ability of the rock to store water was frequently recognised. However, not all explained how porosity is reduced and not all recognised that the permeability of the rock would also reduce. A small number did not make it clear that the capacity to act as an aquifer would reduce, some just stated it would be affected, without stating for the better or for the worse.

Question 2 (a) (i)

2

(a) The upper part of the Earth consists of the lithosphere and the asthenosphere.

(i) Describe the physical properties of the lithosphere.

....

.... **[1]**

Most candidates knew the lithosphere is the solid, rigid and brittle outer layer of the Earth. Some digressed into describing chemical properties such as composition, which were not asked for in the question. A minority were confused with the asthenosphere and stated it is partially melted or a rheid, answers best reserved for Question 2 (a) (iii).

Question 2 (a) (ii)

(ii) What indirect evidence has been used to locate the base of the lithosphere?

.... **[1]**

Most candidates accessed the mark for this question. Seismic waves or seismic surveys were the most common correct answers provided. A few stated seismic tomography or EM surveys. Incorrect answers included gravity surveys and borehole drilling.

Question 2 (a) (iii)

(iii) Describe and explain the property of the asthenosphere that enables it to play a key role in plate tectonics.

....

....

....

.... **[2]**

This was well answered with many candidates accessing credit. The rheid, partially melted state of the asthenosphere was recognised by most and many were able to explain how this facilitates the movement of the lithospheric plates above. Discussion of ridge push and slab pull was allowed for the explanation mark. However, some explained the importance of the asthenosphere as a source area for magma which did not answer the question.

Question 2 (b) (i)

(b) Sir George Airy used gravity anomalies to explain the theory of isostasy.

(i) Explain what is meant by isostasy.

....

....

....

.... **[2]**

Candidates found this question challenging and only a minority scored any marks. There were a number of 'no responses'. It was clear some candidates were confused with the height of land relative to sea level, rather than the height at which the lithosphere sits above the asthenosphere. Possibly due to confusion with isostatic sea level changes or the use of wooden blocks floating in water to model isostasy.

Of those who scored any marks, the most common correct explanations were for an understanding of isostatic adjustment or rebound, usually given in the context of a melting ice sheet, or that the height at which the lithosphere floats depends on its thickness or density. Very few conveyed the idea that it is the theoretical state of equilibrium between the Earth's lithosphere and asthenosphere.

Question 2 (b) (ii)

(ii) Describe and explain how gravity anomalies can be used as indirect evidence for the theory of isostasy.

....

....

....

.... **[2]**

Candidates also found this question demanding. Only the correct terms positive and negative were accepted for describing gravity anomalies. Some gave general descriptions of positive and negative gravity anomalies resulting from density differences but did not relate their answer to isostasy, or the density of crustal rocks in relation to mantle rocks. A significant number thought mountain ranges would produce positive gravity anomalies due to the large thickness of crust in these areas. Misunderstanding that there is less dense continental crust in place of denser mantle rocks in the roots of mountains, so a negative gravity anomaly is produced.

It was clear that some were mixed up with the use of gravity surveys in geophysical exploration. To attain credit candidates needed to refer to the density of crustal rocks on a large scale, rather than small scale areas of crust with positive or negative anomalies due to the presence of dense metallic mineral deposits or low-density salt dome evaporites.

Question 2 (c)*

(c)* Describe the geodynamo theory of the Earth's magnetic field **and** explain how it can provide indirect evidence for the processes operating within the Earth's core.

....

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....

.... **[6]**

Many candidates were able to access some credit for their answers, even if it was just Level 1 for simple statements such as the Earth's core is made of iron/nickel and the outer core is liquid and the inner core is solid. But there were some 'no responses'

Those who showed a sound grasp of how the Earth's magnetic field originates from the movement/convection of iron/nickel in the liquid outer core or gave good explanations of how remanent magnetism recorded in rocks provide evidence that the direction of the Earth's magnetic field has changed over time often attained Level 2.

Few were able to achieve Level 3 as most answers lacked sufficient detail of how the outer core acts as a self-exciting dynamo, with the movement of molten iron generating electric currents, which in turn induce magnetism. Exemplar 1 shows an example of a response that addressed both parts of the question to achieve Level 3, 6 marks.

Some misunderstood that the second part of the question asked for how the magnetic field can provide indirect evidence for the processes operating in the Earth's core, rather than what is the indirect evidence for composition or state of the core. These candidates digressed into discussion of indirect evidence such as meteorites or seismic wave behaviour, which were not relevant. Others described convection currents in mantle rocks which attained no credit, as mantle processes have nothing to do with the origin of the Earth's magnetic field.

Exemplar 1

The Earth's magnetic field is created through the movement of iron-bearing minerals in the ~~outcore~~ outer core ~~th~~ through convection currents. This creates an electrical current and ~~[illegible]~~ that ~~p~~ induces a~~n~~ magnetic field. This suggests that the outer core ~~e~~ is a ~~liqui~~ fluid since it has the ability to flow. This also suggests the core contains iron to create a magnetic field and that the core has high temperatures to cause convection currents. The Earth's magnetic field can undergo a reversal which also suggests that the core has some ability to flow further suggesting that the outer core is liquid. **[6]**

Exemplar 1 is a concise response that includes enough correct content to attain Level 3, 6 marks. The candidate has addressed both parts of the question. For the first part, they have described the geodynamo theory of the Earth's magnetic field in a well understood way and have included the correct sequence of formation of an electromagnet.

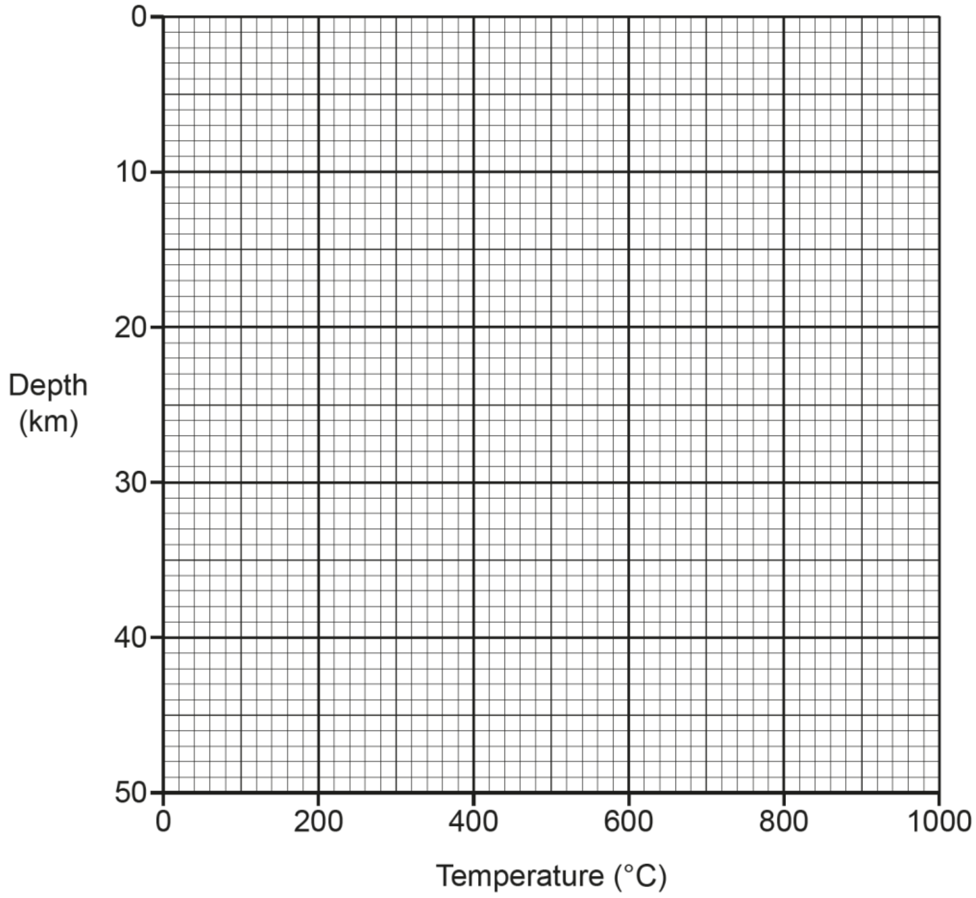
For the second part, they have explained how the Earth's magnetic field provides indirect evidence for processes operating in the Earth's core – high temperatures producing convection currents within the liquid iron and magnetic reversals showing that the liquid in the outer core is able to flow.

Question 2 (d) (i)

(d) The temperature change with depth (geothermal gradient) for **Region X** and **Region Y** in the Earth are shown in the table.

Region X		**Region Y**	
Depth (km)	**Temperature (°C)**	**Depth (km)**	**Temperature (°C)**
0	0	0	0
10	250	5	160
20	500	15	480
30	750	20	
40	1000	25	800

(i) Plot the data from the table for **Region X** and **Region Y** on the grid.



[3]

This graph plotting exercise was done well. Errors included not plotting the 0, 0 points for the two regions and not joining the points with lines to show the two gradients.

Question 2 (d) (ii)

(ii) Determine the temperature at a depth of 20 km for **Region Y**. Write your answer in the table. **[1]**

Most candidates read off 640°C correctly to attain the mark. Those who had mis-plotted points in Question 2 (d) (i) or had not joined between the 15 and 25 km points with a line were more likely to give wrong answers.

Question 2 (d) (iii)

(iii) Use the data from the table to calculate the geothermal gradient for **Region Y**.

Geothermal gradient = ... Unit = ... **[2]**

Many were able to calculate the geothermal gradient. Nevertheless, not all candidates followed the prompt to use data from the table, while others did the division the wrong way round placing the change in distance on top and the change in temperature below.

Some gave incorrect units. Placing distance (km) before temperature (°C) was a common error, as was placing the degrees symbol after the C rather than before, while others omitted the letter C. A small number gave an answer of 640°C, which they should have given as the answer to Question 2 (d) (ii).

Question 3 (a) (i)

3

(a) Attenuation is an important factor to consider when compiling hazard maps used for seismic risk analysis.

(i) Define the term **attenuation** when applied to seismic waves.

....

.... **[1]**

Attenuation was reasonably well understood but few were able to articulate a correct definition to attain the mark. Incorrect answers included stating it is the strength of the waves or the amount of damage sustained in an area, suggesting confusion with earthquake magnitude and intensity.

Question 3 (a) (ii)

(ii) Explain why high-frequency seismic waves are more strongly attenuated than low-frequency seismic waves.

....

.... **[1]**

Many candidates found it difficult to explain why high-frequency seismic waves are more strongly attenuated than low-frequency seismic waves. Many were confused between wave frequency and wave speed. Few could explain that high-frequency waves have more oscillations per second or that as a result they transfer energy to the material they are travelling through faster.

Question 3 (a) (iii)

(iii) The Mercalli Scale is used to measure earthquake intensity, rating earthquakes on the amount of damage produced in any given place.

Describe and explain why earthquake intensity depends on the nature of the underlying rock.

....

....

....

.... **[2]**

Few candidates accessed all the credit available for this question. It was clear that some did not comprehend the meaning of the term earthquake intensity, even though a definition was provided in the question. Rather than comparing the difference in earthquake intensity between strong competent rocks (lower intensity) and weak incompetent rocks (higher intensity), many compared the different ways rocks can deform, such as brittle/faulting versus ductile/folding. These candidates often arrived at the incorrect conclusion that competent rocks would result in higher intensities as they are more likely to fracture.

There was confusion about the difference between hard and soft rocks, versus strong and weak rocks. It is the competence (strength) of the underlying rock that controls the amount of earthquake damage. Competent rocks have lower earthquake intensities because seismic waves travel through them easily, so they absorb less energy per unit area. Many had this the wrong way round and suggested that the intensity would be higher if the underlying rock is competent as they thought more energy, rather than less, would be transferred to the rock. Even simple ideas that unconsolidated rocks/sediments amplify ground shaking or may undergo liquefaction were missed by most.

Question 3 (b)

(b) Seismic hazard risk analysis can be used to produce hazard maps that summarise geological data for use by government bodies (e.g. for purposes such as disaster planning and public education).

Describe **two** limitations and **two** strengths of hazard maps.

....

....

....

....

....

.... **[4]**

Many answers to this question about the limitations and strengths of hazard maps referred to unspecified hazards, risks and damage. Such answers were too general and vague to attain more than 1 or 2 marks credit at most. To access the full range of marks, candidates needed to refer to specific geological hazards such as earthquakes. Hazard maps are used to suggest where (location) and how big (magnitude) an earthquake or other geological hazard event is likely to be. Many candidates seemed unaware that hazard maps cannot be used to predict timing.

Marks were most often awarded for suggestions that the maps are visual and easy to understand, help non-specialists to prepare, or show areas unsuitable for building or where built structures need strengthening/earthquake-proofing. Many candidates did not include the basic detail that a strength of hazard maps is they show the position of geological features such as known faults or underlying rock types.

Some suggested that the intensity of the next event may differ but did not use the technical term magnitude. Others stated a hazard map would allow mitigation measures to be implemented but did not specify what measures. Some repeated information given in the question that hazard maps allow planning or public education, without further elaboration. Suggesting hazard maps show areas suitable for evacuation routes was creditworthy, but suggesting they give warning to allow people to evacuate was not.

Question 3 (c)

(c) Probabilistic forecasting is a method used to determine the likelihood that an earthquake might occur in a certain area over a given period of time.

Critically analyse the statement 'the social consequences of probabilistic forecasting outweigh any benefit'.

....

....

....

....

....

.... **[3]**

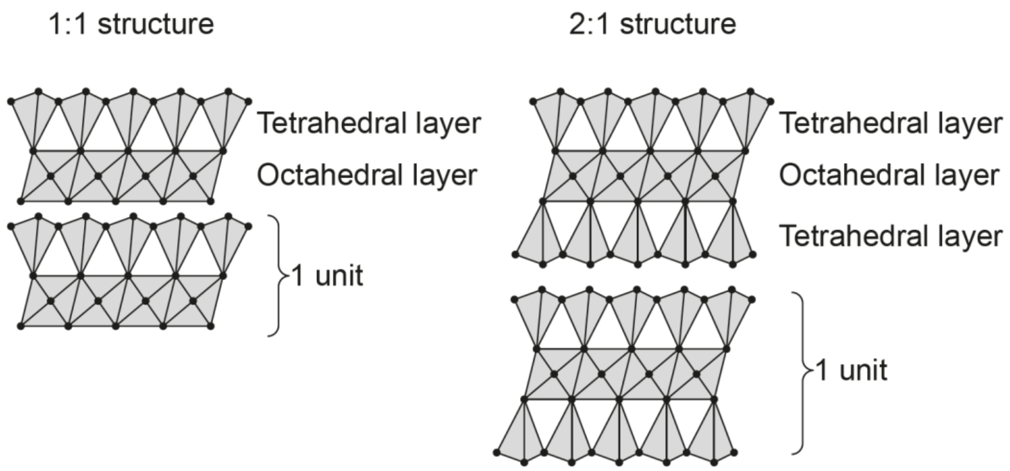
Most candidates managed to access some credit for their answers, usually for weighing up the positive social consequences of probabilistic forecasting against the negative social consequences. Few achieved more than 2 marks and it was clear that many did not understand what probabilistic forecasting means. There was a lack of comprehension that, while probabilistic forecasting gives information about the time period over which an earthquake of a particular magnitude is likely to occur (timing), it is unlikely to be precise enough to allow for evacuations. For example, a probabilistic forecast that a magnitude 6.7 earthquake is likely to happen within the next 30 years is not going to help with knowing exactly when to evacuate citizens, but it would help to allow people to prepare themselves and their property for a possible earthquake.

Hazard maps versus probabilistic forecasting

Hazard maps mainly provide information about where (location) and severity (how big), while probabilistic forecasting gives information about when (timing). However, neither allow an accurate prediction of exactly when, where or how big an earthquake or other geological hazard will be.

Question 3 (d) (i)

(d) Most clays can be classified as 1:1 or 2:1. These ratios refer to the proportion of tetrahedral sheets to octahedral sheets. The arrangement of layers and the method of bonding between the layers affects the properties of different clay minerals.



(i) Complete the table by matching the correct clay mineral to its type and properties.

kaolinite **phyllite** **smectite**

Type	Clay mineral	Properties	
1:1		Non-expanding	Low shrink swell
2:1		Expanding	High shrink swell
2:1	Vermiculite	Limited expansion	Medium shrink swell
2:1	Illite	Non-expanding	Low shrink swell

[2]

More than half of the candidates knew kaolinite is a non-expanding, low shrink-swell clay with a 1:1 layer structure, whereas smectite is an expanding, high shrink-swell clay with a 1:2. A few were taken in by the phyllite option, even though phyllite is a metamorphic rock type and not a clay mineral.

Question 3 (d) (ii)

(ii) A significant proportion of the UK land area is at risk of damage due to the shrinking and swelling of clays.

Describe and explain **one** chemical soil treatment that engineers can use to mitigate the problem of shrinking and swelling clays.

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....

....

.... **[2]**

This question proved challenging, and only a minority of candidates were able to access any credit. Of those who correctly named a chemical treatment such as the use of lime, few went on to achieve the explanation mark. Many merely repeated the information given in the question that it is used to prevent shrinking and swelling. Naming cement as the chemical treatment was allowed, as cement contains lime. However, discussion of the use of cement in grouting or shotcrete was not. These are treatments that physically infill and reduce pore space, so are not chemical treatments.

A handful of candidates attempted to explain the second option in the mark scheme involving reducing ferric/Fe^{3+} iron to ferrous/Fe^{2+} iron to decrease negative surface charge or to increase interlayer cation fixation. However, answers were confused, and few, if any, mentioned the use of bacteria in this process.

Question 4 (a) (i)

4

(a) Amphibians evolved from more primitive tetrapods, the lobe-finned fish.

(i) Describe **one** similarity between a lobe-finned fish and an amphibian.

....

.... **[1]**

Fewer than half of candidates were able to provide a correct similarity between a lobe-finned fish and an amphibian. Correct answers mainly related to the number and position of the limbs or the fact that both lay eggs in water. Less successful responses did not use correct technical terminology and referred to legs and arms, or non-specific features such as having two eyes or a backbone.

Question 4 (a) (ii)

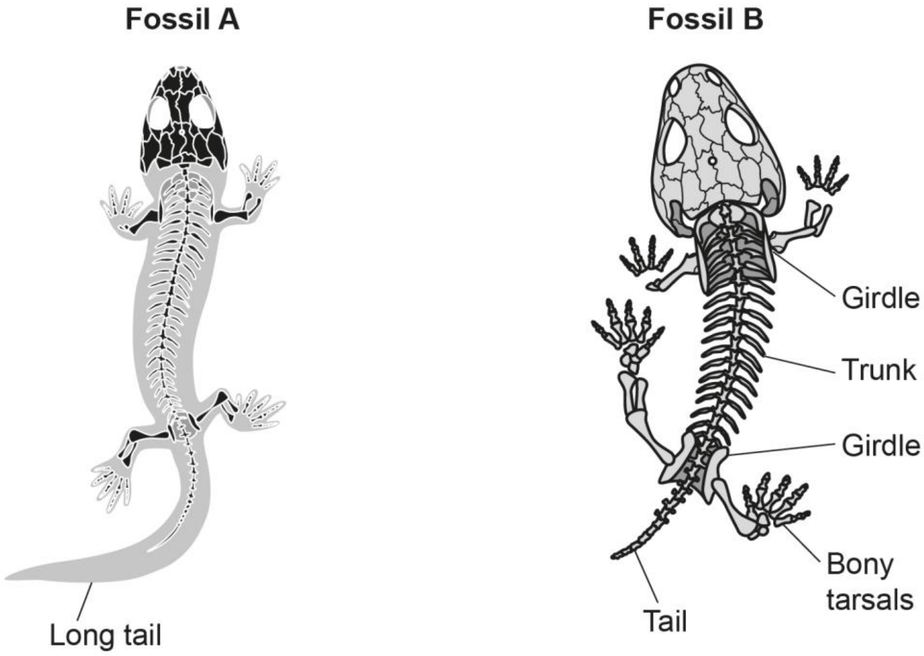
(ii) In which geological period did amphibians first evolve as aquatic organisms?

.... **[1]**

Most candidates had no idea of the correct geological period when amphibians first evolved. Incorrect answers ranged from Cambrian (far too early) to Cretaceous (far too late) with pretty much every other time period in between given as answers. A few quoted an era such as the Mesozoic rather than a period which is what the question asked for.

Question 4 (b)

(b) The diagrams show **two** different amphibian skeletons, fossils **A** and **B**, that evolved to live in different environments.



Describe and explain the differences in the skeletons of fossils **A** and **B**. Indicate the likely environments that each of these organisms lived in.

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....

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....

....

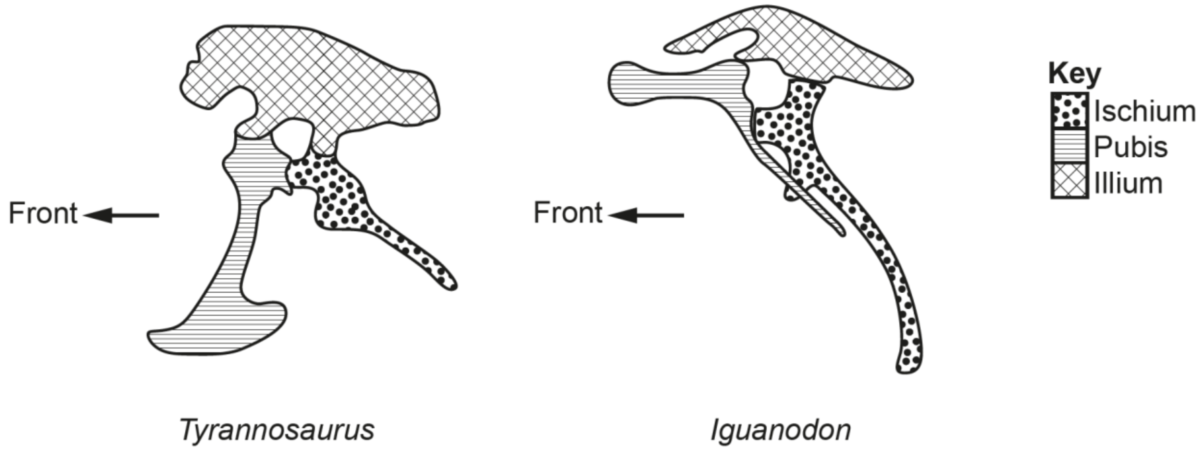
.... **[4]**

This question was answered well with good comparisons made of the differences between the skeletons of the two fossils. Less successful answers referred to the head rather than the skull or got bogged down describing the bony tarsals which are a feature of both, so not relevant to the question.

Not all candidates attained the explanation marks as, although they may have concluded fossil **A** lived in an aquatic environment and fossil **B** in a terrestrial environment, they did not always back this up with acceptable explanations linked to the differing morphologies shown on the diagrams. Explanations relating to fossil **A** were more successful.

Question 4 (c) (i)

(c) The diagrams show the hip-bone arrangements in **two** dinosaurs, *Tyrannosaurus* and *Iguanodon*.



(i) Compare the hip bones of *Tyrannosaurus* and *Iguanodon*.

....

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....

....

.... **[3]**

Successful responses used the information shown in the diagrams to do a point-by-point comparison of the differing arrangements of named hip bones in *Tyrannosaurus* and *Iguanodon*. However, a significant number described the directions of the pubis the wrong way round. Some referred to hip bone when they meant pubis and could not be awarded the mark, as all three bones shown in the diagrams are hip bones. Others described the hip bone arrangements individually and lost marks as they did not make the comparisons asked for in the question. Furthermore, some candidates wasted time trying to explain the differences, which attained no extra credit, as the question only asked for a comparison of the hip bone arrangements.

Question 4 (c) (ii)

(ii) Using information shown in the hip-bone diagrams, describe and explain to which group of dinosaurs *Iguanodon* belongs.

....

....

....

.... **[2]**

The fact *Iguanodon* was an Ornithischian dinosaur was well-known, but the correct the spelling of Ornithischian less so. BOD (benefit of the doubt) was given generously if it was clear that the word was supposed to be Ornithischian. Of those who correctly stated Ornithischian, a significant number then gave an incorrect explanation that the pubis points forwards or that it was lizard/reptile hipped. There was the same issue as in the previous question, referring to hip bone instead of pubis, which could not be credited.

Question 4 (c) (iii)

(iii) Describe and explain **one** morphological adaptation that suggests *Iguanodon* was a herbivore.

....

....

....

.... **[2]**

Most were aware of the morphological adaptations that suggest *Iguanodon* was a herbivore, but not all had sufficient command of correct technical terminology to attain both marks. Imprecise descriptions of the teeth, such as blunt, peg-like (confusion with the Saurischian Sauropod *Diplodocus*) or not sharp, were not precise enough, nor were descriptions such as 4-legged or being able to stand up tall for the postulated stance. The explanation mark for being able to reach vegetation was specifically linked to the paired description that *Iguanodon* could rear up and become bipedal.

Question 4 (c) (iv)

(iv) Pterosaurs and birds independently evolved wings for flight at different times.

State the term used to describe this type of evolution.

.... **[1]**

Few knew convergent evolution as the correct term. Many incorrect answers were given including adaptive radiation, phyletic gradualism, divergent evolution, independent evolution and speciation.

Question 4 (d) (i)

(d) An important evolutionary change was the development of the amniotic egg.

(i) Draw lines to match each **characteristic** with its correct **function**.

Characteristic	Function
Yolk	Membrane containing fluid
Albumen	Fatty food store for developing embryo
Amnion	Separates internal from external environment
Shell	Embryo's water supply

[4]

Done well with most candidates accessing some credit. The correct function of the shell was recognised most often, followed by the yolk. The functions of the albumen and amnion were most frequently confused.

Question 4 (d) (ii)

(ii) Explain how the evolution of the amniotic egg enabled animals to colonise land.

....

....

....

.... **[2]**

Most candidates knew that the amniotic egg provides a watery environment for development of the embryo, so can be laid out of water, but not all gave sufficient explanation to attain a mark. The function of the shell for protection and that the contents of the egg providing everything the embryo needs to develop into a miniature adult were also cited by some candidates.

Question 5 (a) (i)

5

(a) Measuring the settling rates of different sediments can help interpret the environment of deposition in ancient sediments.

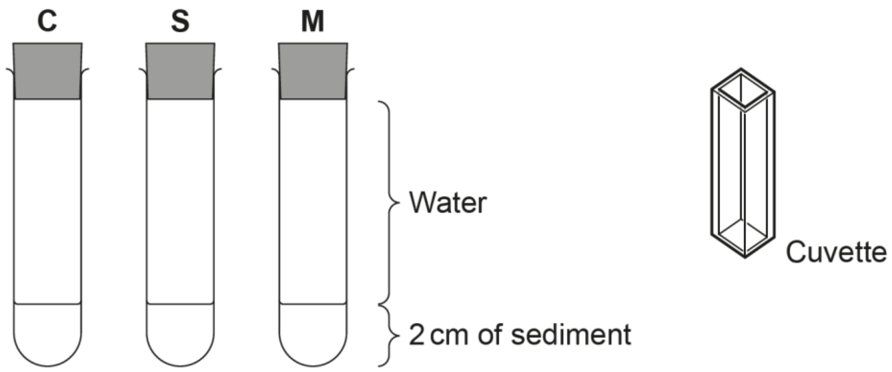
A group of students decided to investigate the effect of sediment type on the settling rate. They decided to use a colorimeter, a device which measures the amount of light that passes through a sample of liquid, where 100% transmission would be pure water with no particulates. Cuvettes are specialised tubes with a square cross section that can be inserted into a colorimeter.

Note the colorimeter must be calibrated to 100% transmission of light with a sample of pure wate at the start of the experiment.

A 590 nm filter (amber) in the colorimeter was used for this experiment.

Method

- Select three types of dried sediment: clay (**C**); silt (**S**) and medium sand (**M**).
- Pour sediment up to a 2 cm line at the bottom of each boiling tube, as shown in the diagram.
- Using tube **C**, fill with water and put in a rubber bung.
- Shake the tube and place in a boiling tube rack.
- Using a pipette, remove some of the liquid from the centre of each boiling tube and transfer to a cuvette.
- Insert the cuvette into the colorimeter and record the % transmission value.
- Leave the cuvette in place and take readings every five minutes over the following twenty five minutes.
- Repeat with tubes **S** and **M** and record the % transmission values.



Boiling tubes before shaking

The results are shown in the table.

	% transmission		
Time (minutes)	**Tube C**	**Tube S**	**Tube M**
0	4.0	15.6	74.0
5	10.2	45.2	78.3
10	16.3	50.0	78.6
15	22.3	47.7	79.0
20	26.5	53.6	79.5
25	26.4	53.7	80.5

(i) Describe and explain the relationship between sediment type and % transmission.

Use the information given in the table.

....

....

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....

....

.... **[3]**

The most common correct marking point awarded was that the finer the sediment grain size the lower the % of light transmission, and the second most common was that medium sand (**M**) settled out fastest. However, many candidates used all the answer lines repeating the same marking point in different ways for a maximum of 1 mark.

Some candidates did not gain any description marks as they did not make comparisons between the different grain sizes tested, which is what the question asked. Very few appreciated that by the time the sample had been transferred to the cuvette, most of the medium sand particles had already settled out.

Not all noted the command word explain and explanations were less successful. Few recognised that the differences in % transmission could be explained due to the finer, lighter particles being held in suspension or the coarser, heavier particles settling out faster. A significant number of candidates referred to an incorrect idea that the coarser grains will have more/larger spaces between the grains allowing more light transmission. There was confusion about density – in this case it is the greater weight of the larger particles that cause them to settle out faster, as small and large particles can have the same density.

Question 5 (a) (ii)

(ii) The percentage change in % transmission for tube **C** between 0 and 25 minutes has been calculated as 560%.

Calculate the percentage change in % transmission for tube **M** between 0 and 25 minutes.

Give your results to **3** significant figures.

Tube **M** = ... % **[3]**

Candidates tended to get 0 or 3 marks for this question. Of those who knew the formula for percentage change and did the correct calculation, the majority correctly quoted their answer to 3 significant figures. The most common incorrect answer was 109% - these candidates forgot to subtract the initial value before dividing by the initial value and multiplying by 100.

Question 5 (a) (iii)

(iii) Which experiment (**C**, **S** or **M**) would you choose to model sediment flow in a fast-flowing river? Give a reason for your answer.

....

....

.... **[1]**

Although **M** was the most popular choice not all gave an acceptable reason that either medium sand is the largest/coarsest sediment size, or a fast-flowing river is a high energy environment. If candidates chose **C** or **S** and justified their answer that the grains would be held in suspension in a fast-flowing river, they could also attain credit.

Question 5 (a) (iv)

(iv) Describe **one** health and safety hazard that must be considered for this experiment.

....

....

.... **[1]**

Candidates were familiar with health and safety hazards and this question was answered well. Broken glass was the most common correct health and safety hazard cited, followed by water/sand spillages causing a slip hazard.

A minority were confused by the term boiling tube and thought it would be hot so there would be a risk of burns and scalds. Wearing safety glasses to avoid getting sediment in the eyes was not credited as this is a standard laboratory safety precaution.

Question 5 (a) (v)*

(v)* Analyse and evaluate the experimental procedure provided. Suggest improvements to the experiment to yield more accurate results.

....

....

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....

....

.... **[6]**

Candidates coped well with assessing the method of an experiment which may have been unknown to them. Most were able to extract some pertinent information from the text to evaluate the experimental procedures and/or suggest some improvements. Those who took careful note of the question and confined themselves to analysing and evaluating the experimental procedures and suggesting improvements were most successful. However, not many candidates managed to do both in sufficient detail to attain Level 3. Exemplar 2 shows an example of a response that addressed both requirements of the question to achieve Level 3, 6 marks.

Some candidates got sidetracked into assessing how well the experiment could be used help to interpret information about environments of deposition which was not asked for. A few even went as far as to describe fieldwork procedures to collect sediment samples from rivers. In addition, some went on to describe how they would analyse the data which was not necessary as the question only asked about the experimental procedure. Discussion of data analysis would have been best saved for Question 5 (b).

Exemplar 2

Instead of using 2cm sediment, use sediment
samples of the same mass, because clay has finer grains,
~~it~~ more ~~tht~~ will fit into 2cm of the tube, therefore measuring
mass will make results more accurate as there is the
same quantity of sediments in each. Ensure each tube
contains the same volume of water, measure this
before adding it, using a measuring cylinder.
Shake each tube for the same amount of time, measure
using a stopwatch. This ensures each sediment sample
undergoes the same agitation.
Put equal volumes of each sample into each cuvette
to make sure the colorimeter reading is accurate.
All of these improvements will improve the reliability
and accuracy of the ~~result~~ results.

This candidate response is typical of a response that fulfilled the criteria for Level 3. The candidate has analysed the experimental procedures provided and, although their evaluation is mostly implicit, their justification of suggested improvements show they have recognised some limitations of the method used. Their recommended improvements are clear and detailed, including the use of specific measuring equipment, such as a measuring cylinder and stopwatch, to increase accuracy.

OCR support

The Teach Cambridge website includes key documents, supporting guides and suggested PAG activities to support teaching of the practical endorsement component of the OCR A Level Geology course. In addition, the published practical endorsement Monitor's reports provide valuable help and support for teachers guiding candidates through the practical skills requirements of the course.

Question 5 (b)

(b) Describe an experiment that could be completed in the laboratory to investigate the deposition of cross-bedding in sediments.

You should include details of how you will collect data, any sampling methods that you would use and how you will process your data.

You may use an annotated diagram to illustrate your answer.

....

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....

.... **[4]**

There were some 'no responses' to this question, but most candidates made an attempt to describe an experimental method that could be used to investigate the deposition of cross-bedding in sediments.

Descriptions of experiments simulating a unidirectional current in water or in air (wind) were both accepted. Some lost marks as they referred to ripples or using a bidirectional current which would not produce cross-bedding. Not many gave precise details of what measuring equipment they would use such as a ruler, tape measure, protractor, clinometer or stopwatch. Few suggested varying the speed of water flow. A small number did suggest using photographs or video recording to show the change over time.

Many candidates forgot to include any details of how they would collect and process the data, limiting their mark to a maximum of 3. Of those who did describe data collection methods, the most common marking point awarded was for repeat measurements, but candidates had to specify using the repeats to find a mean/average to attain this mark. Few suggested measuring the height, wavelength or dip of the cross-beds produced.

Some of the less successful responses ignored the prompt 'in a laboratory' and described fieldwork investigations involving sampling river sediments or measuring cross-bedding in outcrop exposures. A small number appeared to be describing a different experiment that could be used to generate folds using two colours of sand in a container and pushing the sand from one side with a piece of card or plywood.

Question 6 (a) (i)

6 Read the text below, then answer the questions that follow.

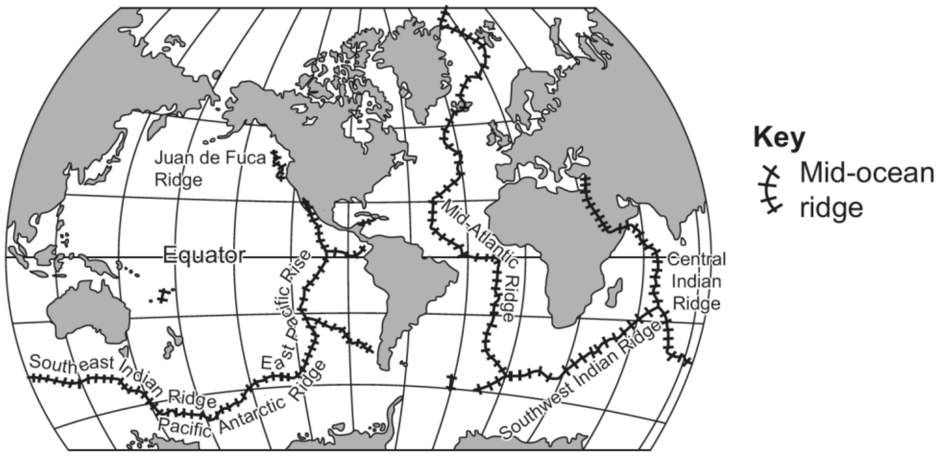
The Origins of the Plate Tectonics Paradigm?

The plate tectonic paradigm developed over a period of time, as new ideas, observations and models arose. The earliest model was called the geosynclinal model. This model used contraction theory to explain mountain building events, known as orogeny, to explain the existence of the Appalachian and Caledonian mountain ranges. This was followed by continental drift theory, proposed by Alfred Wegener in 1915. He proposed no mechanism, but noted that continents fitted together, rather like a jigsaw.

Mechanisms for the movement of plates evolved over time to explain earlier observations. In 1929 British geologist Arthur Holmes proposed that the Earth produces heat by radioactive decay. He also suggested that the Earth was losing heat through volcanic activity. He suggested that there could be mantle convection to enable dispersion of heat and linked this to continental drift with mantle convection driving this process. Holmes' textbook 'Principles of Physical Geology' became widely used and respected by academics.

Alex du Toit was a South African geologist who compared stratigraphy from different parts of the world – Africa, South America, Australia, India, Antarctica and Arabia. In 1937 he suggested the idea that these were all once joined in a supercontinent called Gondwanaland.

In 1962 the American geologist Harry Hess proposed the theory of seafloor spreading, based on ocean basin research during WWII and evidence from the global seismic network which was set up to monitor nuclear tests during the Cold War. He described new crust development at oceanic ridges.



Simplified map showing the positions of mid-ocean ridges, identified during and after WWII.

In 1954 the American geologist Hugo Benioff studied deep-focus earthquakes, up to around 700 km depth, and was the first to plot these earthquakes to identify island arcs as a narrow band. He linked this to the idea of subduction of the Earth's crust.

In 1965 J Tuzo Wilson wrote a paper entitled 'A New Class of Faults and Their Bearing on Continental Drift' where the offset nature of transform faults was noted.

In 1966 Lynn Sykes then noted that 95% of earthquakes occur in belts and identified about 12 major plates and described their relative motion.

In 2021 a group of researchers from Toronto, using supercomputer modelling, showed that the plates on which Earth's oceans sit are being torn apart by massive tectonic forces occurring away from plate boundaries. There may be a need to modify current ideas based on this evidence.

(a)
(i) Describe evidence for the geosynclinal model, which attempted to explain the presence of mountain ranges.

....

....

....

.... **[2]**

Few candidates achieved more than 1 mark for this question. The most common mark awarded was for recognising that it was thought that mountain ranges formed as wrinkles as the Earth cooled and contracted. However, many merely repeated the information given in the text that mountains formed by contraction. Others explained the formation of mountain ranges using modern plate tectonics theory which did not answer the question.

More successful responses focused on and attempted to give evidence for the geosynclinal model, such as the discovery of marine fossils in rocks in mountain belts, showing they originated from sediments deposited in marine basins.

Question 6 (a) (ii)

(ii) Using evidence from the text and your own knowledge, evaluate the statement 'the plate tectonics paradigm has now been solved'.

....

....

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....

.... **[4]**

There were some good answers to this question, but few scored maximum marks. More successful responses picked out the progression from early theories which lacked mechanisms for plate movements, to later ones which attempted to give explanations of the processes involved.

Some used evidence from the text to suggest that, for the most part, the basic model of plate tectonics is now resolved, particularly with the refinements of slab pull and ridge push. However, many concluded that the recent discovery of plates being torn apart by massive forces away from plate boundaries suggests the paradigm is not completely solved.

Few candidates referred to specific examples of recent technological advancements that are improving our understanding of plate tectonics. Many just repeated sections of the text from the question paper, with no elaboration or evaluation. It was clear that some candidates did not understand the term paradigm (a framework of shared theories and research methodologies most often used in the sciences).

Question 6 (a) (iii)

(iii) Harry Hess was the first person to describe hot spots. Describe **one** piece of evidence for the formation of hot spots.

....

.... **[1]**

This question was not answered particularly well. A significant number of candidates contradicted themselves as they described volcanic island arcs away from plate boundaries, which is incorrect as volcanic island arcs form at convergent plate boundaries. Some did not specify the island chains were volcanic in origin so could not be awarded the mark.

Misconception

?

There is a common misconception that hot spots and island arcs form in the same plate tectonic setting.

Hot spots occur away from plate boundaries and are the surface expression of mantle plumes. A chain of volcanic islands forms, each one younger than the one before, as the lithosphere moves over a stationary mantle plume. The most notable present day example is the Hawaiian island chain.

Island arcs form at ocean-ocean convergent plate margins. Here, partial melting of subducted oceanic crust supplies magma which forms an arc shaped line of volcanic islands. There are many examples around the World, including the Caribbean islands, Indonesia, Japan, New Zealand and the Philippines.

Question 6 (b)

(b) Describe how uniformitarianism and the rock cycle models developed over time.

....

....

....

.... **[2]**

Uniformitarianism was reasonably well-known, but few could go beyond quoting the phrase 'the present is the key to the past' for 1 mark. Better responses touched on the earlier theories of catastrophism or gradualism. Not many named James Hutton as the founder of the theory of uniformitarianism and the rock cycle model. Convincing descriptions of how progressive knowledge of rock-forming processes were linked together to become the rock cycle model were scarce.

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